

Title	STUDIES ON THE MOLLUSCAN FAECES (I)
Author(s)	Arakawa, Kohman Y.
Citation	PUBLICATIONS OF THE SETO MARINE BIOLOGICAL LABORATORY (1963), 11(2): 185-208
Issue Date	1963-12-31
URL	<a href="http://hdl.handle.net/2433/175344">http://hdl.handle.net/2433/175344</a>
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

# STUDIES ON THE MOLLUSCAN FAECES (I)<sup>1)</sup>

KOHMAN Y. ARAKAWA

Miyajima Aquarium, Hiroshima, Japan

---

*With 7 Text-figures*

---

Since Lister (1678) revealed specific differences existing among some molluscan faecal pellets, several works on the same line have been published during last three decades by various authors, i.e. MOORE (1930, '31, '31a, '31b, '32, '33, '33a, '39), MANNING & KUMPF ('59), etc. in which observations are made almost exclusively upon European and American species. But yet our knowledge about this subject seems to be far from complete. Thus the present work is planned to enrich the knowledge in this field and based mainly on Japanese species as many as possible.

In my previous paper (ARAKAWA '62), I have already given a general account on the molluscan faeces at the present level of our knowledge in this field together with my unpublished data, and so in the first part of this serial work, I am going to describe and illustrate in detail the morphological characters of faecal pellets of molluscs collected in the Inland Sea of Seto and its neighbouring areas.

Before going further, I must express here my hearty thanks first to the late Dr. ISAO TAKI who educated me to carry out works in Malacology as one of his pupils, and then to Drs. TAKASI TOKIOKA and IWAO TAKI for reading the original typescript. Thanks are also extended to Dr. TOKUBEI KURODA, Dr. HUZIO UTINOMI, Prof. JIRO SÉNO, Dr. AKIHIKO INABA, MESSRS. AKIO TAKI and ISAO ONAMI for their kind helps given to the present work.

## MATERIALS

Molluscan species of which faecal pellets are treated here are up to fifty in number and belong respectively to forty-one genera, twenty-nine families and four classes as shown below.

---

1) Contributions from the Miyajima Aquarium Laboratory, No. 17.

	Species	Locality	*Type of faeces
POLYPLACOPHORA			
Cryptoplacidae	<i>Acanthochiton rubrolineatus</i>	Miyajima Isl.	(S) Subovoid
	<i>A. defilippii</i>	"	(") "
Mopalidae	<i>Mopalia retifera</i>	Kamae	(") "
Lepidochitonidae	<i>Lepidozona coreanica</i>	Miyajima	(") "
GASTROPODA			
Haliotidae	<i>Haliotis japonica</i>	Kamae	(C) Columelliform
Patellidae	<i>Cellana toreuma</i>	Miyajima	(S) Spiral
Acaecidae	<i>Patelloida saccharina lanx</i>	"	(") Orthocylindric
	<i>P. lampanicola</i>	"	(") "
	<i>P. pygmaea</i>	"	(") Rosarioid
	<i>Notoacmea concinna</i>	"	(") Spiral
Trochidae	<i>Monodonta labio</i>	"	(C) Quasi-columelli- form
	<i>M. perplexa</i>	Shirahama	(") "
	<i>Tegula xanthostigma</i>	"	(") "
	<i>T. rustica</i>	Tashima Isl.	(") "
	<i>Kanekotrochus infuscatus</i>	Miyajima	(S) ?
	<i>Tectus pyramis</i>	Kamae	(C) ? Columelliform
	<i>Clithon retropictus</i>	Miyajima	(S) Orthocylindric
Neritidae	<i>Puperita japonica</i>	"	(") "
	<i>Littoraria strigata</i>	"	(") Subovoid
Littorinidae	<i>Tectarius vilis</i>	Shirahama	(") "
	<i>Littorivaga brevicula</i>	Miyajima	(") "
	<i>Nodilittorina granularis</i>	Shirahama	(") "
	<i>Batillaria cumingii</i>	Miyajima	(") Spindle
Potamididae	<i>B. multiformis</i>	"	(") "
	<i>Cerithidea cingulata</i>	"	(") "
	? <i>C. rhizophorarum</i>	"	(") Subovoid
	<i>Conomurex luhuanus</i>	Kamae	(C) Microlithic
Strombidae	<i>Cymatium echo</i>	"	(S) Rosarioid
	<i>Charonia sauliae</i>	"	(C) Microlithic
Bursidae	<i>Bursa bufo</i>	"	(S) Rosarioid
Muricidae	<i>Thais clavigera</i>	Miyajima	(") Orthocylindric
	<i>T. bronni</i>	Tashima	(") "
Buccinidae	<i>Kelletia lischkei</i>	Kamae	(C) Vermiform
Nassariidae	<i>Nassarius hiradoensis</i>	Miyajima	(S) Subovoid
	<i>N. fraterculus hizenensis</i>	"	(") "
Fascioliariidae	<i>Fusinus perplexus</i>	Kamae	(C) Vermiform
	<i>Aplysia juliana</i>	Shirahama	(") Spiro-segmental
	<i>Petalifera punctulata</i>	Mukaishima	(") ?

Elysiidae	<i>Elysia hamatanii</i>	Mukaishima	(S) Orthocylindric
Siphonariidae	<i>Siphonaria japonicus</i>	Miyajima	(") "
Limacidae	<i>Limax flavus</i>	Hatsukaichi	(") Subovoid
PELECYPODA			
Mytilidae	<i>Mytilus coruscus</i>	Tashima	(") Plano-concave
	<i>Septifer virgatus</i>	Shirahama	(") Bi-crescentic
Pteriidae	<i>Pinctada martensii</i>	Kamae	(") Plano-concave
Veneridae	<i>Tapes semidecussata</i>	Miyajima	(") Orthocylindric
Petricolidae	<i>Claudiconcha japonica</i>	"	(") "
Mesodesmatidae	<i>Caecella chinensis</i>	"	(") "
Solenidae	<i>Solen gouldi</i>	"	(") "
Laternulidae	<i>Laternula limicola</i>	"	(") Subovoid
CEPHALOPODA			
Octopodidae	<i>Octopus vulgaris</i>	"	(") Orthocylindric

\* After the terminology shown in my previous paper (ARAKAWA 1962).

(S): Simple faeces, (C): Compound faeces

## DESCRIPTIONS

### Class POLYPLACOPHORA

### Family Cryptoplacidae

#### *Acanthochiton rubrolineatus* (LISCHKE)

Japanese name: *Hime-kehada-hizara-gai*

(Text-fig. 7, C)

The faecal pellets of this species are voided in an ovoid form and grayish white in color, often variegated with shades of yellowish green. They consist almost entirely of rock scrapings with some diatom remains (*Chaetoceros*, *Coscinodiscus* and *Navicula*). The medium proportion of length to diameter of the pellets is 2.27.

#### Measurements :-

Size of animal (mm)	12.5 × 8.4 (Spec. No. 16)									
Length of pellet (mm)	0.89	1.02	0.98	1.02	1.02	1.02	0.92	0.95	0.95	0.92
Diameter of pellet (mm)	0.38	0.45	0.45	0.45	0.45	0.45	0.41	0.45	0.41	0.41
Length/Diameter	2.34	2.26	2.11	2.26	2.26	2.26	2.24	2.11	2.32	2.24

	12.5 × 7.8 (Spec. No. 71)									
L.	1.05	1.02	0.99	0.99	0.98				0.95	
D.	0.45	0.45	0.41	0.45	0.43				0.38	
L/D	2.33	2.26	2.41	2.20	2.28				2.50	

*Acanthochiton defilippii* (TAPPARONE-CANEFRI)Japanese name: *Kehada-hizara-gai*

(Text-fig. 1, A-D)

The pellets take an oval shape and are enclosed within a capsule. Rarely, they may be shed in a form of irregularly convoluted rods. The color of pellets seems to be variable according to the food taken by animals: the pellets may be colored yellowish green by greenish algae or chocolate brown by diatoms. There is a concentration of coarser materials towards the centre. The ratio of length to diameter of the pellets is 2.09.

## Measurements :-

Size of animal (mm)	?(Spec. No. 10)			39.6×28.0 (Spec. No. 31)
Length of pellet (mm)	0.58	0.57	0.58	0.29
Diameter of pellet (mm)	0.31	0.27	0.29	0.13
Length/Diameter	1.87	2.11	2.00	2.15

## Family Mopaliidae

*Mopalia retifera* THIELEJapanese name: *Hige-hizara-gai*

(Text-fig. 1, E)

This species sheds pellets that are oblong ovate in shape and considerably firm in consistency. The texture is fine, smooth and homogeneous. The pellets are composed of algal matters and uniformly colored grayish green. For an animal 52.0 mm long (Spec. No. 72), the pellets average 0.38 mm in length and 0.16 mm in diameter. The mean ratio of length to diameter of the pellets is 2.37.

## Family Lepidochitonidae

*Lepidozona coreanica* (REEVE)Japanese name: *Yasuri-hizara-gai*

(Text-fig. 7, D-D')

The pellets are greatly elongated and cigar-shaped in outline without any external sculpture. The surface is not smooth but rather coarse in texture. They are made up almost of rock scrapings containing numerous diatom frustules and spicules of unknown organisms. On an average, the pellet is 1.71×0.56 mm in size, and the mean ratio of length to diameter is 3.06.

## Measurements :-

Size of animal (mm)	20.5×14.2 (Spec. No. 18)										
Length of pellet (mm)	1.78	1.65	1.59	1.88	1.69	1.88	1.75	1.56	1.69	1.58	1.81
Diameter of pellet (mm)	0.54	0.60	0.60	0.54	0.57	0.57	0.51	0.57	0.60	0.54	0.51
Length/Diameter	3.29	2.75	2.65	3.48	2.96	3.30	3.43	2.73	2.81	2.94	3.55

## Remarks :-

Of these eleven pellets examined, one was found quite abnormal in having two distinct localizations of different food contents sharply marked off from each other: one half of the pellet is colored dark green and entirely consisting of algal matters, while the other is grayish white and composed of diatom frustules (Text-fig. 7, D').

## Class CASTROPODA

## Family Haliotidae

*Haliotis (Sulculus) japonica* REEVE

Japanese name: *Tokobushi*

(Text-fig. 7, K-M)

The species emits much complicated faeces. They are composed of columeliform constituent pellets which are irregularly wound and containing a large amount of mucus loosely packed into rods. The rods are enclosed in a thick hardened gelatinous sheath except for an exposed narrow longitudinal groove which might be applied by a typhlosole along the mid-ventral line of the digestive tract. In cross section they are roughly circular, and show two different types of materials in regions: the part opposite the longitudinal groove is full of food contents, while the part around the groove is filled with viscous fluid. Generally, they are shed in pieces four to five times as long as the diameter and colored dark green to yellowish brown. Food contents are composed mostly of well-digested algal matters. For an animal with a shell 12.5 cm long, the faeces range 0.7–0.8 mm in diameter and the average diameter of the constituent pellets is 0.064 mm.

## Family Patellidae

*Cellana toreuma* (REEVE)

Japanese name: *Yome-ga-kasa*

(Text-fig. 7, I)

The faeces are in a form of rod marked with a single sinistral spiral

groove. They are grayish green in color, rather rough in texture, and composed mostly of partially digested algal fragments and a mixture of some minute unidentified particles. The pellets from an animal with a shell 29.0 mm in diameter average 0.41 mm in diameter.

Family Acmaeidae

*Notoacmea concinna* (LISCHKE)

Japanese name: *Kōdaka-aogai*

(Text-fig. 7, F)

The appearance of the pellets of this species is quite similar to that of the preceding one. They are usually light brown in color, but occasionally mottled with a darker hue. They are made up of rather coarse materials, probably of an algal origin. For an animal with a shell 1.9 mm long and 0.62 mm high, the pellet-diameter fluctuates from 0.45 to 0.48 mm.

*Patelloida (Asteracmea) lampanicola* HABE

Japanese name: *Tsubomi*

(Text-fig. 1, J-K)

The pellets are in a form of cylindrical rod consisting of loosely packed coarse materials mingled with the gelatinous substance. For an animal with a shell 0.73 cm high and 1.29 cm long, the pellets average 0.28 mm in diameter.

*Patelloida pygmaea* (DUNKER)

Japanese name: *Hime-kozara*

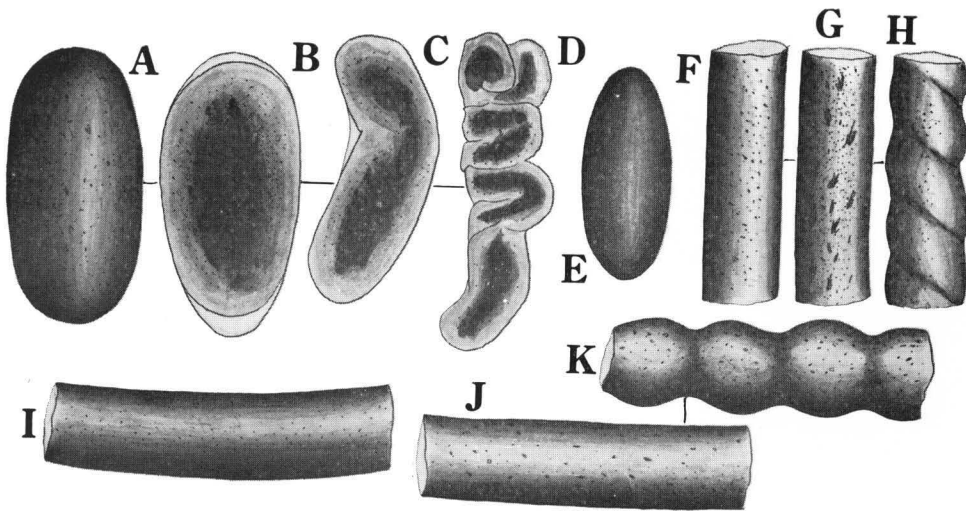
(Text-fig. 1, F-H)

This species emits cylindrical or constricted rod-shaped pellets. They are light yellowish green in color, soft in consistency and rather coarse in texture. They are composed of algal fragments and a mixture of unidentified micro-organisms. An animal with a shell 1.2 cm long and 0.6 cm high, yields the pellets with a diameter of 0.16-0.19 mm.

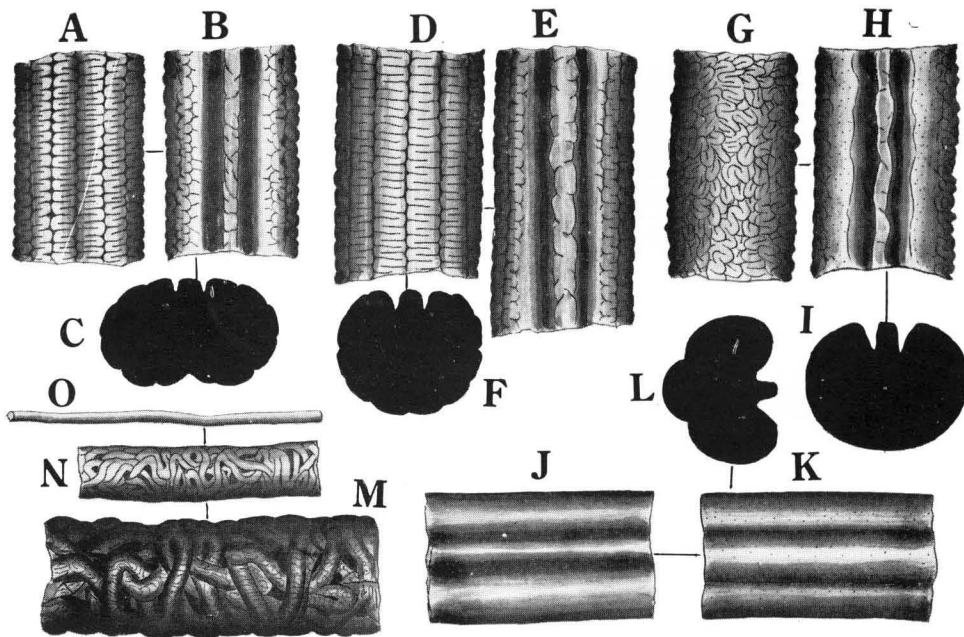
*Patelloida (Collisellina) saccharina lanx* (REEVE)

Japanese name: *Uno-ashi*

(Text-fig. 1, I)

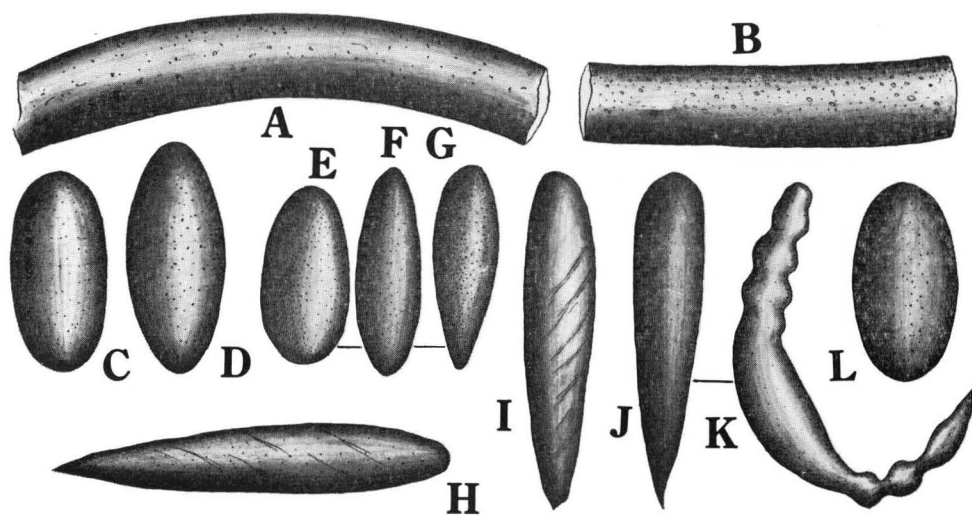


Text-fig. 1. Faecal pellets of : A-D...*Acanthochiton defilippii*, E...*Mopalia retifera*, F-H...*Patelloida pygmaea*, I...*Patelloida saccharina lanx*, J-K...*Patelloida lampanicola*.

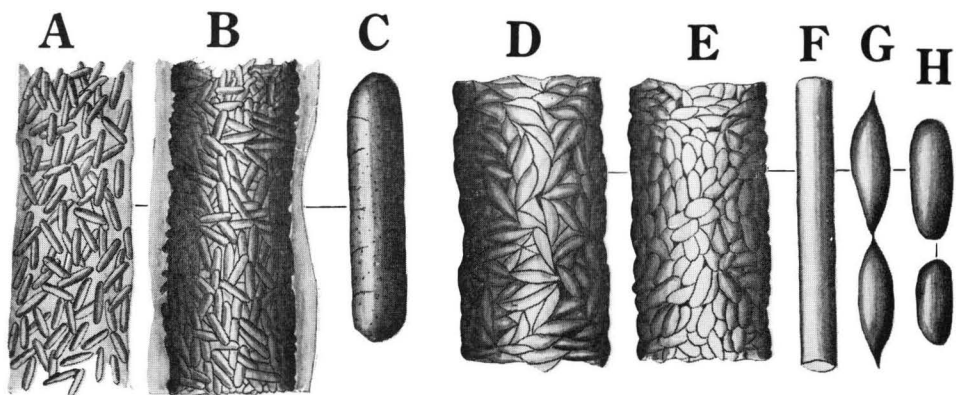


Text-fig. 2. Faecal pellets of : A-C...*Monodonta perplexa*, D-F...*Tegula xanthostigma*, G-I...*Tegula rustica*, J-L...*Kanekotrochus infuscatus*, M-O...*Tectus pyramis*.

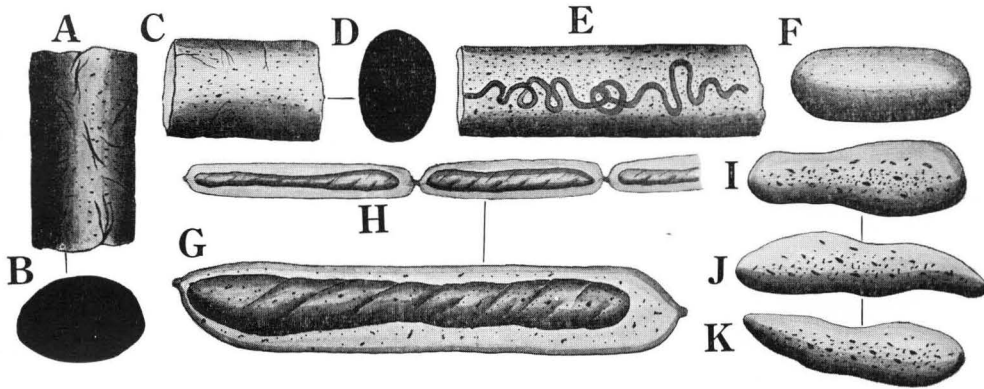




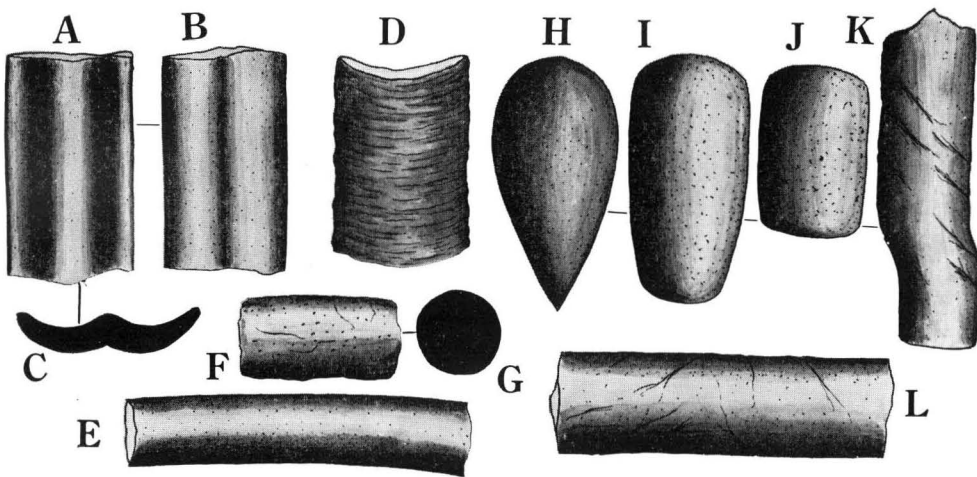
Text-fig. 3. Faecal pellets of : A...*Clithon retropictus*, B...*Puperita japonica*, C...*Nodilittorina granularis*, D...*Tectarius vilis*, E-G...*Littoraria strigata*, H...*Batillaria multiformis*, I...*B. cumingii*, J-K...*Cerithidea cingulata*, L...*C. rhizophorarum*.



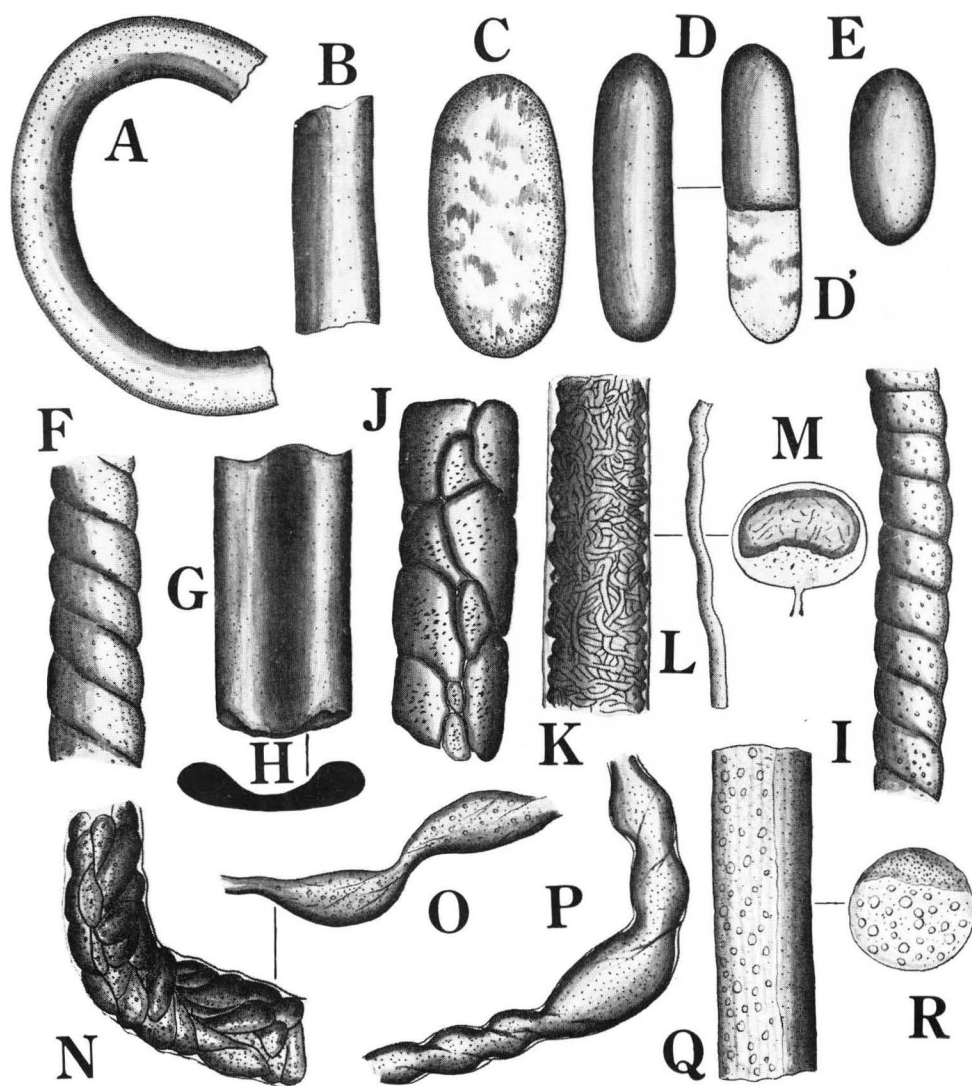
Text-fig. 4. Faecal pellets of : A-B...*Charonia sauliae*, C...Constituent pellet of the same species, D-E...*Conomurex luhuanus*, F-H...Constituent pellets of the same species.



Text-fig. 5. Faecal pellets of : A...*Thais bronni*, B...Cross-section of the same pellet, C...*T. clavigera*, D...Cross-section of the same pellet, E...*Petalifera punctulata*, F...*Nassarius fraterculus hizenensis*, G-H...*Aplysia iuliana*, I-K...*Limax flavus*.



Text-fig. 6. Faecal pellets of : A...*Septifer virgatus*, dorsal aspect, B...Ventral aspect of the same pellet, C...Cross-section of the same pellet, D...*Pinctada martensii*, E...*Tapes semi-decussata*, F...*Laternula limicola*, G...Cross-section of the same pellet, H-K...*Caecella chinensis*, L...*Solen gouldi*.



Text-fig. 7. Faecal pellets of : A...*Siphonaria japonica*, B...*Claudiconcha japonica*, C...*Acanthochiton rubrolineatus*, D-D'...*Lepidozona coreanica*, E...*Tritia hiradoensis*, F...*Notoacmea concinna*, G...*Mytilus coruscus*, H...Cross-section of the same pellet, I...*Cellana toreuma*, J...*Fusinus perplexus*, K...*Haliotis japonica*, L...Constituent pellet of the same species, M...Cross-section of the same pellet, N...*Kelletia lischkei*, O...Constituent pellet of the same species, P...*Bursa bufo*, Q...*Octopus vulgaris*, R...Cross-section of the same pellet.

The pellets are rod-shaped, cylindrical in outline and smoothly surfaced, and usually shed together with an amount of mucus. They consist of algal fragments and unidentified minute particles. The color is uniformly grayish green. For its friable consistency, they are generally voided in pieces two to five times as long as the diameter. For an animal with a shell 1.23 cm long, the pellet-diameter varies 0.13 to 0.22 mm.

#### Family Trochidae

##### *Monodonta labio* (LINNÉ)

Japanese name: *Ishi-datami*

Unlike other members of the class so far examined, this species sheds greatly complicated faecal pellets. The pellets are in the form of a cylindric rod usually cut into much shorter pieces by occasionally formed transverse clefts. They are grayish green in color and roughly circular in cross-section. On the side corresponding to the ventral side of the alimentary tract, there are two deep longitudinal grooves (ventro-lateral grooves) with a conspicuous mid-ventral ridge between them. The other (dorsal) side of the pellets is somewhat concave to form a slight longitudinal hollow. Each lateral margin of the ventral band including those two grooves is usually smooth, but the band floor is marked with about ten indistinct longitudinal ridges densely undulating laterally. The pellets are composed mostly of rather coarse algal fragments and a mixture of sand grains and some amount of diatom remains such as *Navicula* sp., *Thalassiothrix* sp., etc. The pellets emitted from an animal 2.1 cm high and 1.95 cm wide, range from 0.59 mm to 0.77 mm in diameter.

##### *Monodonta (Neomonodonta) perplexa* PILSBRY

Japanese name: *Kubire-kurozuke*

(Text-fig. 2, A-C)

The appearance of faecal pellets of this species resembles that of the preceding one. A prominent mid-ventral longitudinal ridge is defined between the ventro-lateral grooves. The dorsal side is slightly depressed to form a shallow mid-dorsal hollow. Moreover, the whole surface of the pellet is marked with eleven obscure longitudinal ridges which are densely undulating laterally on the dorsal to lateral side of the pellet but become insignificant towards the ventral side. The zig-zag arrangement of undulations is maintained clearly on the dorsal to lateral side but it becomes irregular to the ventral. The pellets

are composed almost of algal fragments being mixed with numerous diatom frustules, foraminiferan shells and other organisms. For an animal with a shell 1.1 cm high, the pellets average 0.7 mm in diameter.

*Tegula (Chlorostoma) xanthostigma* (A. ADAMS)

Japanese name : *Kuma-no-ko-gai*

(Text-fig. 2, D-F)

The pellets are roughly cylindrical in shape and usually broken into very short pieces. A prominent mid-ventral longitudinal ridge is found distinctly between the two deep longitudinal grooves each with a V-shaped section. Most surface of the pellets excepting the ventral side is marked with about eleven obtuse longitudinal ridges densely undulating laterally; and loops on any two ridges adjoining each other are arranged symmetrically. The ventral side of the pellets is nearly smooth and without any undulations. The pellets are made mostly of partially digested algal matters or else of a mixture of these with numerous diatom frustules and other organisms. For an animal with a shell 1.53 cm high, the diameter of pellet is 0.80 mm on an average.

*Tegula (Chlorostoma) rustica* (GMELIN)

Japanese name : *Koshi-daka-gangara*

(Text-fig. 2, G-I)

This species emits pellets that are roughly cylindrical in shape. The color varies from dark chocolate green to yellowish brown. On the ventral side of the pellets, there is an upstanding mid-ventral ridge bordered on each side by a deep longitudinal groove, while on the opposite side is discerned a slight longitudinal depression. The dorsal and lateral surface of the pellets is furnished with fine undulations much more irregular than in the preceding species. Contrarily, the ventral surface is usually smooth and without any undulations. The pellets are composed almost of algal fragments, sand grains and other unidentified matters. An average diameter of the pellets shed from an examined animal is 0.48 mm.

*Kanekotrochus infuscatus* (GOULD)

Japanese name : *Kaneko-chigusa*

(Text-figs. 2, J-L)

The pellets are in the form of a cylindroid rod, usually voided broken into

shorter pieces. There are four longitudinal grooves on the surface, two of which are deep and running on each side of the mid-ventral ridge, while other two are shallow and wide, and running on each side of the mid-dorsal ridge. Of these four ridges, the mid-ventral one is the smallest, while other three are all well-developed and nearly equal in size, so that the pellets assume the shape of a clover-foil in cross section. They are formed mostly of fully digested algal matters and some diatom frustules. For an animal with a shell 0.83 cm high, the pellets average 0.24 mm in diameter.

*Tectus pyramis* (BORN)

Japanese name: *Gin-takahama*

(Text-fig. 2, M-O)

The faeces consist of many filamentous constituent pellets irregularly convolved and packed into asymmetric rods which shape is maintained by mucus. In section, the faeces are roughly elliptical with a shallow indistinct longitudinal hollow on the dorsal side. The constituent pellets are then made of still minor constituent rods and mucus. These rods are normally composed of coarse materials probably of an algal origin. The color ranges from dark green to orange yellow. On an average, the diameter of faeces is 1.11 mm, that of constituent pellets 0.39 mm and that of minor constituent rods 0.09 mm for an animal with a shell 4.95 cm high.

Family Neritidae

*Clithon retropictus* (MARTENS)

Japanese name: *Ishimaki-gai*

(Text-fig. 3, A)

The pellets take the form of a typical cylindric rod. They are greenish brown in color, fine and smooth in surface texture, and composed of fully digested materials probably of an algal origin mixed with diatom frustules. The pellets from an animal with a shell 0.98 cm high, average 0.35 mm in diameter.

*Puperita (Heminerita) japonica* (DUNKER)

Japanese name: *Ama-gai*

(Text-fig. 3, B)

The faecal pellets of the present species resemble those of the preceding

one so closely that it is impossible to make a distinction between those. The pellets of these two species are shed usually embedded in a large amount of mucus. An average diameter of the pellets from an animal with a shell 0.60 cm high is 0.29 mm.

### Family Littorinidae

#### *Littoraria strigata* LISCHKE

Japanese name: *Hime-uzura-tamakibi*

(Text-fig. 3, E-G)

The pellets are emitted in an ovoid form and carry a small amount of mucus with them. They are rather firm in consistency and fine and homogeneous in surface texture. The coloration varies with the component material and actually from dark greenish brown to light grayish yellow. They are usually composed of coarse algal fragments and a mixture of other rock scrapings. The ratio of length to diameter of the pellets is 2.2.

#### Measurement:-

Size of animal (cm)	1.24×0.83 (Spec. No. 53)									
Length of pellet (mm)	0.57	0.54	0.57	0.44	0.57	0.67	0.54	0.51	0.62	0.51
Diameter of pellet (mm)	0.29	0.22	0.25	0.21	0.29	0.29	0.24	0.24	0.24	0.24
Length/Diameter	2.0	2.5	2.3	2.1	2.0	2.3	2.3	2.1	2.6	2.1

	1.30×0.90 (Spec. No. 2)										
L.	0.54	0.51	0.51	0.56	0.65	0.69	0.62	0.55	0.53	0.69	0.62
D.	0.27	0.29	0.22	0.22	0.22	0.24	0.22	0.21	0.29	0.22	0.23
L/D	2.0	1.8	2.3	2.6	2.9	2.9	2.5	2.6	1.8	3.1	2.7

#### *Tectarius vilis* PHILIPPI

Japanese name: *Ibo-tamakibi*

(Text-fig. 3, D)

The general appearance of pellets is the same as that of the preceding species. They are dark brown in color, firm in consistency and fine and homogeneous in texture. The pellets shed from an animal with a shell 7.5 mm high and 5.6 mm wide, average 0.52 mm in length and 0.22 mm in diameter. The mean proportion of length to diameter is 2.4.

#### *Littorivaga brevicula* (PHILIPPI)

Japanese name: *Tamakibi*

The present species sheds pellets quite similar to those of the preceding two species. The average ratio of length to diameter of the pellet is 1.98.

Measurements :-

Size of animal (cm)	1.33×1.20 (Spec. No. 1)						
Length of pellet (mm)	0.81	0.91	0.82	0.86	0.74	0.83	
Diameter of pellet (mm)	0.43	0.43	0.44	0.39	0.39	0.42	
Length/Diameter	1.88	2.12	1.86	2.21	1.89	1.98	

*Nodilittorina granularis* (GRAY)

Japanese name : *Arare-tamakibi*

(Text-fig. 3, C)

The faecal pellets share the feature common to the group. The mean ratio of length to diameter of the pellet is 2.10.

Measurements :-

Length of pellet (mm)	0.54	0.57	0.51	0.60	0.51	0.41	
Diameter of pellet (mm)	0.24	0.29	0.26	0.26	0.29	0.18	
Length/Diameter (mm)	2.3	2.0	2.0	2.3	1.8	2.3	

Family Potamididae

*Batillaria cumingii* (CROSSE)

Japanese name : *Hoso-umi-nina*

(Text-fig. 3, I)

This species voids pellets roughly fusiform in shape. The distal end\* of the pellets is rounded, while the other end is pointed. They are enough consolidated, occasionally with faint discontinuous spiral striations on the surface, colored yellowish green, and composed mostly of unidentified fine materials.

Measurements :-

Length of pellet (mm)	1.40	1.60	1.37	1.56	1.65	1.49	1.43	1.43	1.40	1.73	1.45
Diameter of pellet (mm)	0.24	0.29	0.29	0.27	0.27	0.27	0.32	0.29	0.27	0.32	0.29

*Batillaria multiformis* (LISCHKE)

Japanese name : *Umi-nina*

(Text-fig. 3, H)

---

\* The "distal end" of the oval pellet refers to the foremost part first coming out from the anus.



The above description may be applied to this species, excepting that here the pellets are equally bluntly pointed at both ends and tend to be more elongated than in the preceding species. They are grayish green in color and considerably firm in consistency. The average ratio of length to diameter is 6.35.

Measurements :-

Size of animal (mm)	28.0×12.0 (Spec. No. 5)				27.0×12.0 (Spec. No. 49)				
Length of pellet (mm)	2.00	1.80	1.90	2.00	2.07	2.13	2.23	1.75	1.81
Diameter of pellet (mm)	0.35	0.26	0.26	0.26	0.29	0.32	0.35	0.35	0.41
Length/Diameter	5.71	6.92	7.31	7.61	7.14	6.65	6.37	5.00	4.41

*Cerithidea (Cerithideopsilla) cingulata* (GMELIN)

Japanese name : *Kawa-ai*

(Text-fig. 3, J-K)

The pellets are roughly elongate ellipsoidal in outline, circular in section and greenish brown in color. The distal end of the pellets is rounded, while the other end is sharply pointed and tapering. The surface is smooth and homogenous in texture.

? *Cerithidea rhizophorarum* A. ADAMS

Japanese name : *Futo-henatari*

(Text-fig. 3, L)

The faecal pellets are oval in outline, with rounded ends, and usually shed together with a modicum of mucus. They are dark green in color and rather solid in consistency. The pellets average 0.34 mm in length and 0.15 mm in diameter.

Family Strombidae

*Conomurex luhuanus* (LINNÉ)

Japanese name : *Magaki-gai*

(Text-fig. 4, D-H)

The faeces of this species consist of numerous variform constituent pellets aggregated into rods which are usually broken into shorter pieces one to two times as long as the diameter. Even the constituent pellets of faeces shed by the same animal within a short period vary greatly in shape as illustrated in

Text-fig. 4, F-H. This may be attributed to the degree of solidification of food materials in the alimentary tracts. The constituent pellets are usually enclosed in a capsule and the color varies from light to dark green. They are composed of well-digested materials including some translucent spherical bodies which may be some animal eggs. The diameter of faeces from an animal 5.25 cm high, range from 2 to 4 mm and that of constituent pellets average 0.069 mm.

### Family Cymatiidae

#### *Cymatium (Monoplex) echo* KURODA et HABE

Japanese name : *Kako-bora*

The faeces are ovoid or ellipsoidal and most frequently found joined together in a string. They are light yellowish brown and with dark stripes. The surface is rather smooth and without any sculptures but occasional clefts.

#### Measurements :-

Length of pellet (mm)	1.67	1.57	1.52	1.74	2.35	1.39	1.61	0.87	1.95	1.48
Diameter of pellet (mm)	1.08	1.04	0.95	1.00	1.26	0.87	0.52	0.48	0.74	0.78
L.	1.30	1.52	1.87	0.95	1.52					
D.	0.74	0.75	0.82	0.74	0.95					

#### *Charonia sauliae* (REEVE)

Japanese name : *Bōshū-bora*

(Text-fig. 4, A-C)

The faeces consist of numerous ellipsoidal constituent pellets loosely bound together into rods with an indefinite section by a large amount of mucus. In general, the constituent pellets of faeces are enough consolidated and ellipsoidal in shape four to five times as long as the diameter. When the animal has been fed on the asteroid, *Asterias pectinifera*, two different types of constituent pellets are shed by the same animal within a short time; one is orange in color, rather fine in texture and composed entirely of well-digested flesh tissue but containing no skeletal materials, while the other is pure white in color, somewhat coarse in texture and formed solely of indigestible spicules of the animal. Such a differentiation may be resulted from a specialized function of sorting food materials in early stages of the digestive process. The con-

stituent pellets obtained from the faeces with a diameter of 0.63-0.80 mm range in size as follows:

Length of constituent pellet (mm)	0.24	0.14	0.20	0.24	0.20	0.19	0.15	0.20	0.28	0.20
Diam. of constituent pellet (mm)	0.05	0.04	0.04	0.06	0.06	0.04	0.04	0.05	0.05	0.05

#### Family Bursidae

*Bursa (Tufufa) bufo* (LINNÉ)

Japanese name: *Ō-naruto-bora*

(Text-fig. 7, P)

The faecal pellets are shed in a form of rod enveloped in a capsule. They are usually translucent and yellowish gray in color. The faeces are composed of a large amount of viscous fluid containing some shell pieces, remains of plankton animals and diatom frustules. For an animal with a shell 16.3 cm long, the pellets average 1.1 mm in diameter.

#### Family Muricidae

*Thais clavigera* KÜSTER

Japanese name: *Ibo-nishi*

(Text-fig. 5, C-D)

This species voids pellets that are rod-shaped with an elliptical section and usually broken into shorter pieces. The surface is fine and homogeneous in texture, but marked occasionally with transverse clefts. The pellets are uniformly dark green in color, and formed of fully digested unidentified materials containing numerous spicules and diatom frustules. An animal with a shell 2.30 cm long and 2.05 cm wide, voids the pellets ranging 0.78-0.91 mm in diameter.

*Thais bronni* (DUNKER)

Japanese name: *Reishi*

(Text-fig. 5, A-B)

The description for the preceding species may also be applied to this species, except that the color is grayish green in this species. The pellet-diameter varies 0.84-0.64 mm.

## Family Buccinidae

*Kelletia lischkei* KURODAJapanese name: *Migaki-bora*

(Text-fig. 7, N-O)

The faeces are rod-shaped with a 3.5 mm medium diameter and consist of cylindrical constituent pellets which are constricted at intervals in a form of chain. They are uniformly dark chocolate brown in color and enveloped in a gelatinous sheath. The constituent pellets are again enclosed in a thin sheath and composed mostly of unidentified small spherical particles mixed with finer materials.

## Family Nassariidae

*Nassarius (Reticunassa) hiradoensis* (PILSBRY)Japanese name: *Une-mushiro*

(Text-fig. 7, E)

The faeces are in a form of oval pellets usually embedded in a modicum of mucus. The surface is smooth and fine in texture and yellowish brown in color. The ratio of length to diameter is 2.09.

## Measurements :-

Size of animal (cm)	1.60 × 0.78 (Spec. No. 23)			
Length of pellet (mm)	0.47	0.45	0.46	0.47
Diameter of pellet (mm)	0.20	0.22	0.22	0.22
Length/Diameter (mm)	2.35	2.05	2.09	2.05

*Nassarius (Reticunassa) fraterculus hizenensis* (PILSBRY)Japanese name: *Hime-une-mushiro*

(Text-fig. 5, F)

The faeces are quite similar to those of the preceding species. The pellets from an animal 1.52 cm long, average  $0.43 \times 0.22$  mm; and the mean proportion of length to diameter is 1.5.

## Family Fasciolariidae

*Fusinus perplexus* (A. ADAMS)Japanese name: *Naga-nishi*

(Text-fig. 7, J)

The faeces are cylindrical, rod-shaped and composed of numerous variform constituent pellets. The color is light or dark brown, rather variable according to the nature of food taken. The pellets are composed of unidentified fine materials containing some minute spherical bodies. For an animal with a shell 13.8 cm long, the pellets average 1.72 mm in diameter.

Family Aplysiidae

*Aplysia juliana* QUOY et GAIMARD

Japanese name : *Amakusa-ame-furashi*

(Text-fig. 5, G-H)

This species voids faeces somewhat complicated in shape; they are elongate ellipsoid and contain each a dextral helicoidal pellet within a large amount of fluid medium. Faeces are usually found being united in strings and enveloped in a thin transparent sheath. The pellets are yellowish brown, rather delicate in consistency and coarse in surface texture. They are composed mostly of coarser materials probably of an algal origin. The pellets average 0.54 mm in diameter.

*Petalifera punctulata* (TAPPARONE-CANEFRI)

Japanese name : *Umi-namekuji*

(Text-fig. 5, E)

The faeces are translucent, light greenish brown in color and cylindrical in shape. They are characterized by a dark brown constituent pellet being irregularly convolved within the faeces. They are made up substantially of a large amount of gelatinous substance mixed with algal fragments, various spicules and diatom frustules. The pellets average 0.35 mm in diameter.

Family Elysiidae

*Elysia (Elysia) hamatanii* BABA

Japanese name : *Kuro-midori-gai*

The faeces are translucent, cylindrical rod-shaped, and voided embedded in a small amount of mucus. They are formed almost exclusively of an amount of gelatinous matter containing sparsely some unidentified micro-organisms. The pellets average 0.01 mm in diameter.

## Family Siphonariidae

*Siphonaria japonica* (DONOVAN)Japanese name: *Karamatsu-gai*

(Text-fig. 7, A)

The pellets are cylindric in shape and greenish yellow in color. The surface is not smooth but somewhat coarse in texture. They are made up solely of rather coarse algal fragments. For an animal 0.97 cm long, the pellets measure 0.45 mm in diameter on an average.

## Family Limacidae

*Limax flavus* LINNÉJapanese name: *Kōra-namekuji*

(Text-fig. 5, I-K)

The pellets are roughly elliptical in outline, brownish gray in color and somewhat coarse in texture. They are devoid of any surface sculpture, though usually uneven on the surface. The pellet-size ranges from 2.73 mm long and 0.91 mm in diameter to 3.91 mm long and 1.00 mm in diameter.

## Class PELECYPODA

## Family Mytilidae

*Mytilus coruscus* GOULDJapanese name: *I-gai*

(Text-fig. 7, G-H)

The faecal pellets are in the form of ribbon with two free edges rolled gently upwards to bear a crescent section and without any external sculptures. They are so delicate that they are usually voided broken into much shorter pieces. They are brownish green in color and fine and homogeneous in surface texture. For an animal with shells 4.55 cm long, the ribbons average 0.54 mm in width.

*Septifer (Mytilisepta) virgatus* (WIEGMANN)Japanese name: *Murasaki-inko*

(Text-fig. 6, A-B)

The faeces are ribbon-shaped, and very friable in consistency; the central portion is thicker than other parts and folded on the side corresponding to the dorsal side of the alimentary tract to form a mid-dorsal ridge, and a shallow but wide mid-ventral groove on the opposite side. The free edges slightly turn up dorsads so that the ribbon assumes a bi-crescent-shape in cross section. For an animal 1.65 mm long, the pellets average 0.64 mm in width.

#### Family Pteriidae

##### *Pinctada martensii* (DUNKER)

Japanese name: *Akoya-gai*

(Text-fig. 6, D)

The faeces are thin corrugated ribbons with two lateral edges weakly rolled up dorsads. As is often the case with ribbon-like faeces, they are fragile and shed broken to pieces. In cross-section, they are usually crescent; starved animals seem to show a tendency to produce thinner and more delicate ribbons with two lateral edges strongly rolled in to touch each other. The coloration is variable, from grayish brown to orange yellow, according to staple of food taken by the animal. On an average, the width of ribbons is 1.86 mm for an animal with shells 4.92 cm long.

#### Family Veneridae

##### *Tapes (Amygdala) semidecussata* REEVE

Japanese name: *Asari*

This species sheds pellets that are rod-shaped, somewhat sandy in appearance and roundish in section. They are usually voided together with a large amount of mucus. They are yellowish brown in color and formed of somewhat coarse detritus mingled with some sand grains. The pellets from an animal with shells 2.73 cm long, average 0.16 mm in diameter.

#### Family Petricolidae

##### *Claudiconcha japonica* (DUNKER)

Japanese name: *Semi-asari*

(Text-fig. 7, B)

The pellets are rod-shaped, circular in section and grayish brown in color.

The surface is smooth and fine in texture. They are formed of unidentified fine materials and some diatom frustules. The pellets voided from an animal 1.09 cm long range 0.19–0.20 mm in diameter.

#### Family Mesodesmatidae

##### *Caecella chinensis* DESHAYES

Japanese name: *Kuchiba-gai*

(Text-fig. 6, H-K)

The pellets are dark brown in color, fine in texture and greatly variable in shape. Most frequently faeces are voided in a form of rod, but occasionally in roundish pellets with blunt ends or sometimes with one end blunt and the other sharply pointed. They are composed entirely of fine detritus.

#### Measurements :-

Length of pellet (mm)	0.75	1.30	0.82	0.65	0.70
Diameter of pellet (mm)	0.48	0.45	0.45	0.50	0.43

#### Family Solenidae

##### *Solen gouldi* CONRAD

Japanese name: *Mate-gai*

(Text-fig. 6, L)

The faecal pellets are cylindric and rod-shaped. The surface is fine and smooth except for occasional transverse cracks. For an examined animal, the pellets range 0.95–1.08 mm in diameter.

#### Family Laternulidae

##### *Laternula limicola* REEVE

Japanese name: *Sotōri-gai*

(Text-fig. 6, F-C)

This species sheds roughly oval pellets with truncate ends. They are very firm and densely packed with fine detritus. They are colored yellowish brown and occasionally marked with clefts. The pellets average 0.60 mm in length and 0.31 mm in diameter.



## Class CEPHALOPODA

## Family Octopodidae

*Octopus vulgaris* CUVIERJapanese name: *Ma-dako*

(Text-fig. 7, Q-R)

The faecal pellets are cylindrical rod-shaped with a circular section and enveloped within a thin adhesive sheath. They are striated with numerous fine longitudinal lines on the surface. The color is grayish white when the animal has been fed on fish meat. There can be seen localizations of different materials: the partially digested coarser matters occupy the side corresponding to the ventral side of the alimentary tract, while the finer materials occupy the opposite side of the pellet. The pellet-diameter ranges from 1.0 mm to 3.0 mm.

## REFERENCES

For comprehensive references see Arakawa (1962).

- ARAKAWA, K. Y. (1962): A coprological study on the molluscan faeces. A preliminary note. Jap. Jour. Malac. (Venus), XXII (2), 151-172.
- ITAGAKI, H. (1960): Anatomy of *Semisulcospira bensoni*, a fresh-water gastropod. Ibid., XXI (1), 43, pl. 5, fig. 22.
- KORNICKER, LOUIS S. (1962): Evolutionary trends among mollusk faecal pellets. Jour. Paleont., XXXVI (4), 829-834.
- ŌTA, S. (1959): Studies on feeding habits of *Pinctada martensii*. II. Bull. National Pearl Res. Lab., 5; 429-438.
- (1959a): ———— III. Ibid., 5; 434-438.
- (1959b): ———— IV. Ibid., 5; 439-442.
- (1959c): ———— V. Ibid., 5; 443-449.
- (1961): ———— VI. Ibid., 6; 573-575.
- (1961a): ———— VII. Ibid., 6; 573-575.